THURSDAY, FEBRUARY 21, 1878

THE HEAD-MASTERS ON SCIENCE TEACHING[1]

IT is much to the credit of the head-masters that they should have moved voluntarily in the matter of science teaching. The great majority of them are known to look upon it without hostility, but have hesitated to introduce it into their schools, in ignorance of its educational value, of the time and teaching power necessary, of subjects, methods, cost. Since the Report of the Science Commission all see that it must come, and that it is better for the schools to shape the system to be adopted leisurely and in concert than to wait till it is forced upon them from without. A few schools have already accepted it in principle; a very few have worked it adequately for some years past; to these the Head-Masters' Committee have applied for information, and their published answers are before us.

Questions were issued to the masters of twenty-four schools, of whom nineteen replied. They refer to the time spent on science in actual school work, the percentage of boys taught, the age at which teaching should begin, the subjects included, the methods and texts employed, the intellectual results apparent, the value of laboratory work, the cost of appliances, the influence, good and evil, of university scholarships, the text-books recommended; and it was requested that the answers might convey not individual theories of what might and ought to be, but a record of what had been and was being done in each particular school.

It is evident that the first question, as to time spent in teaching, is vital to the whole, and should determine primarily the comparative weight due to the answers sent from each head-master. Unfortunately the answers to it are in a great measure unreliable. Only one school gives the total number of its actual working hours; some do, and some do not apparently include hours of "preparation" in their estimate; one large school, Clifton, omits to reckon the extra time given to special classes, and probably others do the same; while Harrow, Magdalen, and Dulwich, all valuable witnesses, make no return. Taking the answers as they stand, eleven of the nineteen schools give from two to four hours only as a maximum per week, inclusive of practical work; and in some cases, at least, this is probably correct, representing also many more schools than are included in the list. Such schools have made a good beginning, are feeling their way to more extended teaching, and will hail the information given in these pages. But their maximum would be thought ludicrous in the case of literature or mathematics; it gives no real chance to science either as a storehouse of useful knowledge, or as a weapon of intellectual training; and accordingly the evidence valuable to schoolmasters is contained mainly in the answers sent by the remaining schools.

These may be tabulated as follows:—

School.	Hours per week given to science in different parts of school.	Percentage of boys learning science.
Bradford	10, 4, 3, 2	No return.
Clifton[1]	10, 4	90
Giggleswick	8, 6, 5, 2	80
King's College ...	7, 5, 5	No return.
Manchester	12, 9, 3½	No return.
Newcastle-under-Lyme	7, 4, 2	90
Taunton	10, 8, 4, 3	87
Wellington	6, 3½, ½	73

As regards the age at which the study should commence, Clifton, Taunton, and Wellington think that it cannot begin too early; the rest give years ranging from ten to thirteen. All the schools agree in teaching chemistry and physics; three teach botany, three geology. All test progress by periodical frequent examinations within the school, Clifton and Taunton specifying the period as once in three weeks. All but one speak highly of the use of note-books; five object strongly to examinations from without, two find them useful. Bradford, Clifton, Taunton, Wellington celebrate the good effects of science as a school subject, from its stimulating power, its bringing apparently dull boys to the front, its inculcating a comprehension of physical law. Six schools make practical laboratory work compulsory; one, Clifton, has regard to special aptitude shown by boys; one alone, Bradford, would not enforce it at all.

The evidence as to cost is complicated; the questions were well arranged, but many of the answers give aggregate sums, without saying how many boys the outlay was calculated to supply. It would seem, however, that the costly appliances of Clifton, including chemical and physical laboratories and lecture-rooms with fittings of every kind, cost about 5*l.* per head of pupils intended to be taught; those of Newcastle about 4*l.* per head; of Giggleswick 3*l.*; of Taunton less than 2*l.*: that is to say, chemistry and physics may be taught for ever to one hundred boys with an original expenditure of 200*l.*, and cannot where money is plentiful cost more than 500*l.* For the further consolation of beginners and of poorer schools we learn that a Clifton master's apparatus for three chemical and three physical lectures a week cost 8*l.* once for all, exclusive of air-pump and balance, and that in lecturing for five years he has not spent 3*l.* a year; while the Taunton master announces that a man with leisure and dexterity to make his own apparatus can begin with table, gas, water, a few shelves, and 5*l.*; and adds that his own lectures cost only 6*d.* each.

Valuable opinions are reported as to the influence exercised by the universities on school teaching. All head-masters know that the mischief inflicted on education by the Oxford and Cambridge system is incalculable, and the opinion finds expression in these answers. To gain a science scholarship a boy must abandon during the last two or three years of his school course all subjects except science, with such a minimum of classics and mathematics as may secure him against a pluck in the Littlego; and, *mutato nomine*, the same is true of candidates for either classical or mathematical scholarships.

[1] Appendix to Report of Head-Masters' Committee, 1877. Answers to Questions on Natural Science.

[1] This is from private information. The returns given in the Report are not so high.

Those who think that school education should be general; that literature, mathematics, and science should share it in fair proportions; and that entrance scholarships at the university should be awarded to general excellence, will understand how the present system disheartens every thoughtful educator, who groans over the intellectual development of his best boys distorted in obedience to this tyranny of special prizes, which he nevertheless must win, or forfeit his reputation as a teacher.

An exhaustive list of text-books is given by the various schools. Some of them are valuable to the teacher only; others indispensable to the pupils. With very few exceptions their price is exceedingly moderate, though expensive books such as Watts' "Dictionary of Chemistry," and Weinhold's "Practical Physics," should have their place in the school library as books of reference.

It is clear that the publication of this Report marks a step in advance along the path of scientific education. It contains not opinions, but facts; not theories of what the teaching should be, but records of what it is; and this not scattered through the discursive pages of a Blue-book, but condensed into a pamphlet of thirty pages. Not less instructive is the comparative unanimity with which different schools, swayed by independent traditions, advancing on different lines, and ignorant of each other's movements, have worked out the same practical results and are teaching the same subjects by the same methods. The problem is virtually solved; the difficulties inherent in the recasting of an ancient system have disappeared so soon as they were honestly faced; and the head-masters, who perhaps looked shyly on advice from without, will listen to it, let us hope, when recommended by their colleagues. To this end the contents of the Report should be summarised, and circulated amongst the schools. It would be easy for the head-masters and science-masters of the schools which have answered questions to constitute an informal committee. A small working sub-committee would soon formulate a scheme of science teaching, based on the conclusions of the Duke of Devonshire's Commission, giving accurate particulars as to methods, books, tests, and cost of teaching chemistry and physics, with further information on the subject of museums, workshops, botanical gardens, and observatories; and this paper, drawn up in the simplest and most practical shape, might be sent at once to all first-class schools with the imprimatur of the entire committee. It would hardly fail to gain converts amongst present schools; each new head-master, appointed, as they are appointed now, with an understanding that they shall find room for science in their curriculum, would hail it as of the highest value; and when compulsory legislation comes, as come it must, the necessary details will all be ready to its hand. W. TUCKWELL

FRANKLAND'S RESEARCHES IN CHEMISTRY[1]

Experimental Researches in Pure, Applied, and Physical Chemistry. By E. Frankland, Ph.D., D.C.L., F.R.S., &c. (London: Van Voorst.)

THE section (II.) that Dr. Frankland devotes to his researches in Applied Chemistry is not the least interesting of the work, though the chief topics are Gas and Water. The author's investigation of White's process for manufacturing hydrocarbon gas by passing steam over red-hot coke, and carbonising the gas in the retort, led to the clear distinction of the illuminating from the non-illuminating constituents of the hydrocarbon gas and of ordinary coal-gas. It was shown that marsh gas is valueless as a light producer during combustion, and that the luminosity of a gas flame is due to the heavier hydrocarbons present, whose illuminating value can be deduced from analysis and expressed in terms of olefiant gas. Such an indirect method of estimating the illuminating value of a sample of gas is certainly interesting, but it is clearly unsafe; for it involves the assumption that the illuminating value is directly proportional to the percentage of a hydrocarbon mixture of unknown constitution, calculated somewhat empirically into equivalents of the well-defined ethylene. Moreover, some recent experiments by Dittmar seem to show that ethylene does not contribute nearly so much to the luminosity of a hydrogen gas flame as benzole vapour. Hydrogen containing as much as 10 per cent. of ethylene gave a very feebly luminous flame, while hydrogen charged with only 3 per cent. of benzole vapour afforded a brilliant light when the gas was burned. Fortunately Dr. Frankland does not wholly rely upon the method in comparing—as he does in his introductory remarks on the gas investigations—the London supply of 1851 with that of 1876; for he has partially employed the photometer as a check. In 1851 the London gas supply contained 7·01 per cent. of olefiant gas, or its equivalent of other illuminating hydrocarbon, while in 1876 the percentage was 7·02. From these data it was concluded that there was no difference in illuminating power although the 1876 gas should be, according to the Act of Parliament, four candles better than that of 1851. Dr. Frankland says:—

"The improvement of the coal gas sold in London has been only imaginary, for no real alteration has been effected. It has been made to appear better, by testing it with improved burners; but, as consumed by the burners almost universally employed, it gives no more light in 1876 than it did in 1851—a conclusion which is confirmed by the results of simultaneous comparative trials made by Mr. Humpidge with two burners, one of them similar to those by which London coal gas was tested in 1851, and the other, the so-called 'gas referee's burner,' at present employed in testing London coal gas. At 4 P.M. on June 6, 1876, the gas supplied by the Chartered Company to South Kensington Museum gave, when consumed at the rate of five cubic feet per hour from the 1851 test-burner, a light equal to 11·1 standard candles, and on June 28, at 3 P.M., a light equal to 10·5 standard candles; but when the same gas was tested at the same hours by the present referee's burner, it gave, when consumed at the same rate, a light equal to 14·3 candles on June 6, and a light equal to 14·5 candles on June 28."

There is no doubt that the photometric determinations in the above cases substantially agreed with the analytical results, which latter may, in consequence, be accepted so far. The general result, however, is eminently unsatisfactory to all persons interested, save the gas company.

The second inquiry undertaken in connection with gas was that on the igniting point of coal-gas. The chief facts elicited possess so much general interest that we may mention them here. They were:—1. That coal-gas ignites at a much lower temperature than marsh-gas, but at a higher temperature than hydrogen or carbonic oxide.

[1] Continued from p. 319.